25th ANNUAL FORENSIC SCIENCE DAY

STUDENT INTERNSHIP PRESENTATION PROGRAM

TUESDAY, APRIL 6TH, 2021

UNIVERSITY OF TORONTO MISSISSAUGA

FORENSIC SCIENCE PROGRAM

FORENSIC SCIENCE AT THE UNIVERSITY OF TORONTO MISSISSAUGA

Each year, the Forensic Science Program attracts some of the brightest students from across Canada and worldwide to take part in our unique education experience. The program admits over 200 students per year out of the hundreds who apply, and students transfer to this campus from all across the country. Over the last few years, we have had many students from British Columbia, Alberta, Saskatchewan, Quebec, Nova Scotia, and Newfoundland. Within Ontario, we have students from as far away as Thunder Bay, Windsor, and Ottawa.

Students obtain an Honours BSc Degree in Forensic Science by choosing to complete one of our four Specialist Programs: Forensic Anthropology, Forensic Biology, Forensic Chemistry or Forensic Psychology. Alternatively, students can choose to complete a Forensic Science Major in conjunction with a second major from one of the following disciplines: Anthropology, Biology, Chemistry, or Psychology. In addition to the above programs, the Forensic Science Program also offers a Minor that can be taken in conjunction with any specialist or major program, including those from the Social Sciences and Humanities. This Minor program complements degrees in criminology, sociology, geography, political science, and any other field that intersects with the legal system.

Students in our program learn forensic theory and gain foundational subject matter knowledge, as well as at least one applied skill set through lectures and labs. Today, we are celebrating the hard work and success of our Specialist degree students.

UNIVERSITY OF TORONTO MISSISSAUGA

FORENSIC SCIENCE PROGRAM

INTERNSHIP IN FORENSIC SCIENCE AND THE IMPORTANCE OF MENTORS

All graduates of the Forensic Science Specialist Programs at UTM are required to complete either FSC 481 (the 4th year internship course) or FSC 482/483 (the Collaborative Research courses). In addition to spending approximately 200 hours working on their internships, students in 481 participate in on-the-job training or job shadowing; assisting with routine tasks; and collaborating with a professional forensic specialist on an original research project; students also attend classes on professional practice and research skills. Students in 482/483 gain a similar set of skills undertaking a collaborative research project with faculty at UTM. Experiential learning combined with a first class science degree is the keystone of the UTM Forensic Science Program. Successful internships benefit the student, the mentor, and the agency through an exchange of ideas, learning opportunities, and resources dedicated to addressing a research problem or question of interest to the forensic agency and its employees. Forensic Science Day is the culmination of these partnerships.

In addition to class assignments designed to develop professional skills (a mock job interview, writing a cover letter and resume, practice presentations, critical assessment of colleague's research, and a mock trial), students also learn research skills such as obtaining ethics permission for research and writing a detailed research proposal. After final grading and editing by the course instructor, we anticipate that, with the mentors' approval (and given co-authorship), at least half of the research projects presented today will be accepted for publication in a peer-reviewed journal.

It is our pleasure today to thank the mentors and to praise the initiative and efforts of these very bright students.

THE 25TH ANNUAL FORENSIC SCIENCE DAY

10:20 AM **ZOOM LINK OPENS**

A ten minute casual opening for people to get comfortable and situated within the conference platform.

10:30 AM **OPENING REMARKS & WELCOMING STATEMENT**

DR. TRACY ROGERS
Director, Forensic Science Program
Department of Anthropology, University of Toronto Mississauga

DR. ALEXANDRA GILLESPIE
Principal, University of Toronto Mississauga

UNIVERSITY OF TORONTO MISSISSAUGA

FORENSIC SCIENCE PROGRAM

10:35 AM STUDENT INTERNSHIP PRESENTATIONS

SESSION CHAIR: SHELBY SCOTT

PhD Candidate, Department of Anthropology, University of Toronto

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Drug facilitated sexual assault in Ontario, Canada – drugs detected and their trends over a 5-year time period

10:45 AM BRAEDEN GROSS 12
Impact of toxicological determinations on a SUDEP diagnosis

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Identifying characteristics of cannabis impairment during Drug Recognition Expert (DRE) evaluations.

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Differences between male and female suicide and self-harm behavior among Ontario adolescents: a 5-year retrospective study

11:15 AM NOHA ISMAIL 15
Molecular autopsy in identifying cardiac ion channelopathy and cardiomyopathy heart diseases in sudden cardiac related deaths in young population

11:25 AM HELEN SPROULE 16
Sex Estimation from radiographic measurements of the calcaneus

11:35 AM EMAN FAISAL 17
Assessing the age of adult os coxae using machine learning and 3D point cloud data

11:45 AM SHORT BREAK
Brief intermission on Zoom, presentations resume at 11:55

FSC481Y5

INTERNSHIP IN FORENSIC SCIENCE

JESSICA PENNER

Drug facilitated sexual assault in Ontario, Canada – drugs detected and their trends over a 5-year time period

ABSTRACT

Purpose: This study aimed to identify the drugs detected in cases of drug facilitated sexual assault (DFSA) in Ontario, Canada over the five-year time period from the beginning of 2015 to the end of 2019, and identify trends that may be present. This was accomplished by analyzing the toxicology reports written by the Centre of Forensic Sciences (CFS) for cases of DFSA. This research was performed to clear up misconceptions about DFSA, and to provide information about current drug trends. **Background**: Drug trends in Ontario have changed in recent years, with an increase in opioid prevalence and the legalization of cannabis. Alcohol, cannabis, cocaine, and amphetamines were frequently detected in previous DFSA research. **Methodology**: Toxicology results for sexual assault cases analyzed for drugs or alcohol in the specified timeframe were reviewed. Drugs administered in hospital were eliminated from the results. The frequency of detection of each drug (or drug category) was calculated out of the case total, and trends in specific drugs (or drug categories) of interest were identified using a chi-squared test of independence. Age and sex of the complainant was recorded for demographic data. **Results**: 2,165 cases were reviewed. Ethanol, cannabis, and cocaine were the most frequently detected drugs. Significant (p-value < 0.05) upwards trends were discovered in cannabis and opioids. **Conclusion**: The results from this study indicate that, in recent years, there have been significant increases in the detection of cannabis and opioids in DFSA cases. Alcohol has, however, remained most frequently detected, as is consistent with previous research.

Keywords: forensic science, forensic toxicology, drug facilitated sexual assault, date rape, cannabis legalization, opioid epidemic, novel psychoactive substances

Supervisor: Dr. Karen Woodall, Assistant Professor, University of Toronto Mississauga

BRAEDEN GROSS

Impact of toxicological determinations on a SUDEP diagnosis

ABSTRACT

Purpose: The purpose of this research is to determine the role of toxicology results in the classification of a death as Sudden unexpected death in epilepsy (SUDEP), by analysis of SUDEP and non SUDEP autopsy cases. The research provides insight into the accuracy of the cause of death (COD) determinations by pathologists at the Ontario Forensic Pathology Service (OFPS) and will generate recommendations for SUDEP related COD determinations in the future. **Background**: SUDEP, an exclusionary COD, affects hundreds of Canadians each year. Previous research suggests correct classification of SUDEP can become difficult with increasing case complexity. Toxicology results can complicate interpretation by pathologists, potentially leading to misdiagnosing the COD. Given a lack of evidentiary findings, an appropriate consideration of toxicological findings is important in SUDEP cases. **Methodology**: Using search terms such as history of seizures, COD SUDEP, and searching case history for anti-seizure medication, the OFPS's database was searched for SUDEP related cases. A forensic toxicologist and forensic pathologist reviewed the toxicology findings in these cases, evaluating the original interpretation and amending the COD if needed. **Results**: The search returned 373 Ontarians with a history of seizures/ epilepsy whose deaths occurred between 2016-2019. The likelihood of a possible SUDEP case being misdiagnosed as a toxicology related death was 10% highlighting the need for improved accuracy when investigating SUDEP cases. **Conclusion**: Toxicology results in cases where a death would otherwise be undeterminable/exclusionary lacking alternative evidence/findings, specifically SUDEP, display a significant bias to being misdiagnosed as a toxicology related death.

Keywords: forensic science, forensic biology, epileptic, coroner, drugs, SUDEP, Inquest

Supervisor: Karen Woodall, Professor, University of Toronto Mississauga. Andrew Williams, Pathologist, Ontario Forensic Pathology Service.

RACHEL RAM

Identifying characteristics of cannabis impairment during Drug Recognition Expert (DRE) evaluations.

ABSTRACT

Purpose: The purpose of this study is to determine if recorded observations used by Drug Recognition Experts (DREs) are reliable indicators of cannabis impairment. This research is important because it will provide scientific data for the observations used by DREs to identify drivers under the influence of cannabis. **Background**: DRE evaluations are the main tool used in Canada to identify drug impaired drivers. However, there is limited scientific evidence to support its use in determining cannabis impairment. **Methodology**: 207 DRE evaluations and corresponding urine toxicology results were evaluated to investigate the frequency of physiological and psychophysical indicators in cannabis-only cases. The difference in prevalence of these indicators were compared between cases confirmed by the DRE and toxicology analysis as cannabis-only, polydrug including cannabis and cannabis negative to determine which indicators were specific to cannabis impairment. **Results**: Chi Square Test of Independence identified that eye tremors, lack of convergence, lack of horizontal gaze nystagmus and normal muscle tone were associated with cannabis-only and polydrug including cannabis cases($p<0.05$). Kruskal-Wallis test indicated blood pressure was higher in cannabis-only cases compared to other conditions($p<0.05$). A one-way ANOVA indicated pupil size was larger in cannabis-only and polydrug including cannabis cases($p<0.05$). Psychophysical test performance did not differ between conditions($p>0.05$). **Conclusions**: Psychophysical indicators are useful to determine impairment by a drug and physiological indicators can assist to determine drug class. Both types of indicators should be used together to determine cannabis impairment. These results can assist DREs to correctly identify recent cannabis use.

Keywords: forensic toxicology, THC, drug evaluation and classification program, sobriety tests, marijuana

Supervisor: Dr. Karen Woodall, Assistant Professor, University of Toronto Mississauga; Reed Holland, Constable, York Regional Police

JASMIN ORR

Differences between male and female suicide and self-harm behavior among Ontario adolescents: a 5-year retrospective study

ABSTRACT

Purpose: To identify patterns and differences of self-harm behavior and suicide amongst male and female adolescents aged 10-18 years in Ontario, which can contribute to informing policy decisions on provincial suicide prevention frameworks. **Background**: In Canada, suicide is the second leading cause of death in adolescents. Past research suggests that the ratios of self-harm and suicide rates differ between males and females, and that past self-harming behavior are significant predictors of future suicide. **Methodology**: All 327 adolescent suicide cases from 2014-2018 provided by the Office of the Chief Coroner were reviewed. **Results**: The ratio of male to female suicides was 1.38:1. The ratio of male to female self-harm behavior was 1:1.76. Overall, cutting was the predominant method of self-harm (94.62%), and the predominant death factor was hanging (74%). The most common anatomic sites of self-harm were the left and right lower arms (34.59% and 20.44%, respectively). There was a statistically significant association between sex and presence of self-harm (p=2.1413-10, df=1), between sex and quantity of anatomic sites of self-harm (p=0.013, df=2), and between sex and presence of self-harm with a previous suicide attempt (p=1.12-06, df=3). **Conclusion**: The findings were consistent with the differences in suicide and self-harm patterns between males and female adolescents observed in the literature. Understanding similarities and differences in suicide and self-harm behaviors may be used to tailor appropriate screening and prevention strategies in female and male adolescents in Ontario, and hopefully prevent future cases of adolescent suicide.

Keywords: self-harm, adolescent, suicide, Ontario, forensic pathology, forensic science

Supervisors: Dr. Christopher Ball, Forensic Pathologist, Office of the Chief Coroner; Julie Erbland, Executive Lead, Child and Youth Death Review and Analysis Team, Office of the Chief Coroner; Victoria Snowdon, Research and Data Analyst, Child and Youth Death Review and Analysis Team, Office of the Chief Coroner

NOHA ISMAIL

Molecular autopsy in identifying cardiac ion channelopathy and cardiomyopathy heart diseases in sudden cardiac related deaths in young population

ABSTRACT

Purpose: The purpose of this research is to determine if sudden cardiac death (SCD) cases in young people could be associated with cardiac ion channelopathy or cardiomyopathy. This research demonstrates the importance of molecular autopsy (MA) in understanding cause of death (COD) in undetermined sudden death cases. **Background**: SCD presents a challenge in the field of forensic pathology since most of the cases have negative toxicology and post-mortem examination (PME) findings with no medical condition to help explain the COD. In the young population, SCD is mostly caused by two main inherited diseases which are cardiac ion channelopathy and cardiomyopathy such as: Right ventricular arrhythmogenic cardiomyopathy (ARVC), Dilated cardiomyopathy (DCM), and Hypertrophic cardiomyopathy (HMC). **Methodology**: This study reviewed MA reports with results of variant of unknown significance (VUS), PME findings, and the medical history of a total of 80 cases from 2018-2020 with undetermined or unascertained COD of patients who are under the age of 40. The chi-square test of independence was used to find if there is an association between VUS molecular autopsy findings and the potential cardiac ion channelopathy or cardiomyopathy disease identified by the National Centre of Biotechnology Information database (NCBI) for each mutation. **Results**: The results of the Chi-square test analysis revealed that the cases with the VUS mutations and cardiomyopathy ($p<0.05$), and cardiac ion channelopathy ($p<0.05$) were significantly associated. **Conclusion**: These results demonstrate that MA is a promising genetic screening technique that allows for the identification of the genetic causes of congenital diseases in sudden undetermined death cases.

Keywords: forensic pathology, molecular autopsy, sudden cardiac death, cardiomyopathy, cardiac ion channelopathy

Supervisor: Dr. Maggie Bellis, Forensic Pathologist, Ontario Forensic Pathology Service

HELEN SPROULE

Sex estimation from radiographic measurements of the calcaneus

ABSTRACT

Purpose: The purpose of this research is to develop a method of sex estimation from radiographic measurements of the calcaneus. **Background**: Discriminant functions in forensic anthropology is used to classify unknown variables, individual radiographs, into known groups, male or female. Sex estimation is an important part of the biological profile, to obtain positive identifications. Sexual dimorphism of calcanei is proven in past research. Radiographs produce an exact image of the relevant bone, allowing for analysis when access to the dry bone is impractical. **Methodology**: 100 medial-lateral radiographs of the foot/ankle were collected, 50 males and 50 females. Radiographic measurements collected included: maximum length (MAXL), body height (BH), maximum height (MAXH), and cuboidal facet height (CFH). A subsample of 30 paired calcanei were selected to determine if there is a statistically significant difference between left and right calcanei. The left 30 calcanei of the pairs were used for intra- and inter-observer error. The male and female measurements were analyzed to determine whether a statistically significant difference exists for each measurement (p < 0.05). The measurements will be applied to a statistical program to determine a demarking point for univariate functions, and for multivariate functions a constant, unstandardized coefficients, and a sectioning point. **Results**: A statistically significant difference (p > 0.05) was found for male and female calcanei. For univariate functions accuracies ranged from 72.5%-86.3%, for multivariate the range was 80%-87.5%. **Conclusion**: The present study supplements the literature by providing a method of sex estimation using radiographic measurements of the calcaneus.

Keywords: Forensic anthropology, sex estimation, calcaneus, discriminant functions, radiographs

Supervisor: Shelby Scott, Ph.D. Candidate, University of Toronto Mississauga

EMAN FAISAL

Assessing the age of adult os coxae using machine learning and 3D point cloud data

ABSTRACT

Purpose: The purpose of this research was to develop a method of age assessment on os coxae of modern European adults, between the ages of 18 to 100 years old at the age of death, using machine learning (ML) to aid in mass disaster victim identification (DVI). **Background:** The age assessment process can be prolonged when there are many victims at an investigation. The application of ML varies depending on the aim of a study; however, it accelerates the estimation of an output based on input data. The os coxae (pelvis bone) survives disasters due to surrounding ligaments and muscles. **Methodology:** Images of 3D models of male os coxae (*n*=69), were divided into two subsample groups, a learning group (*n*=55) and an evaluation group (*n*=14). The age ranges were divided using the Calce 2012 method, establishing 3 age ranges: Young: 17-39 years old, Middle: 40-64 years old, and Old: 65+ years old. Point cloud data was extracted by sub-sampling 5000 points on the os coxae. Ground truth information (age, sex, ancestral affiliation, and age classes) was coded into PointNet, a ML supervised algorithm, facilitating learning of the geometric shape of the 3D point clouds. **Results:** PointNet assessed the age classes with an accuracy of 90% within 10.3 milliseconds, with the optimization parameters set as follow: batch size (*n*=10), epoch (*n*=100), learning rate (*n*=0.01), and momentum (*n*=0.9). **Conclusion:** PointNet assessed the age of male os coxae with high accuracy, and speed, accelerating forensic anthropologists' assessment of the biological profile for DVI.

Keywords: forensic science, forensic anthropology, mass disaster, disaster victim identification, DVI, biological profile, artificial intelligence, 3D model, photogrammetry

Supervisor: Dr. Etienne Pillin, Clotho.AI

SHORT BREAK

Brief intermission on Zoom, presentations resume at 11:55

CATHY TRAN

Quantifying force of incisions on pig rib bones

ABSTRACT

Purpose: The purpose of this research is to determine which measurements of incisions, if any, vary by the quantity of force inflicted on pig rib bones through three-dimensional (3D) microscopy. This research is significant as it will increase the understanding of and contribute to guidelines informing quantitative interpretations of force by forensic experts to provide insight into criminal intent. **Background**: The application of force exerts stress, resulting in responding changes (strain) in the bone; however, quantitative research into force as it pertains to incisions on bone in forensic contexts remain limited. **Methodology**: Three distinct sets of incisions were created on fleshed rib bones (n=60), defleshed rib bones (n=83), and rods of synthetic material (n=60) with the assistance of a cutting rig designed to position the knife and bone. Four different knives (two serrated blades and two non-serrated blades) were utilized to create the incisions under force applied by five incremental quantities of mass (4381kg, 8861kg, 13515kg, 18267kg, and 23343kg), with each combination repeated three times. Each incision was modelled and measured via 3D microscopy. **Results**: The two-way ANOVA indicated that depth and length show significant differences across knife type and mass in all samples sets ($p<0.05$), with knife type primarily responsible for driving variation. **Conclusion**: Significant results demonstrate the value of investigating quantitative approaches to force in sharp force trauma wounds, particularly incisions. This research illustrates how 3D microscopy may be utilized to study sharp force trauma in bone.

Keywords: forensic science, forensic anthropology, sharp force trauma, incisions, quantification of force, bone biomechanics

Supervisors: Eugene Liscio, 3D Forensic Analyst, ai2-3D Forensics

NATHANIEL PAQUET

Accuracy study of path volume envelope (PVE) using cast-off bloodstains and FARO Zone 3D

ABSTRACT

Purpose: The purpose of this research is to determine the error associated with the Path Volume Envelope (PVE) calculation in FARO Zone 3D for various, human created cast-off patterns. This research is significant because it will give insight on the uncertainties of a new technique to assess the location of an object's swing path when a cast-off pattern has been created at a crime scene. **Background**: Previous research showed that FARO Zone 3D was successful in estimating a PVE for controlled cast-off stains created by a mechanical device. **Methodology**: Cast-off patterns were created using a human participant that swung a wooden dowel rod at a wall. The dowel rod was dipped in blood prior to creating cast-off patterns and swinging motions were recorded with HTC Vive trackers attached to the dowel rod. A FARO 3D scanner was used in conjunction with a digital SLR camera to record the dimensions of the overall pattern and smaller groups of bloodstains. This data was then Analyzed in FARO Zone 3D to calculate the PVE. The results from FARO Zone 3D were then brought into 3ds Max and the rod's true path of motion was overlaid in the same coordinate space. The PVE's width was recorded to encompass the swing path responsible for creating the cast-off pattern. **Results**: TBD **Conclusion**: FARO Zone 3D can calculate PVEs which can give insight on the location at a crime scene from which a bloodied object was swung. This may be used to support or refute witness testimony or to determine where an object was located during the creation of a cast-off pattern. Further research is necessary to determine the errors associated with different variables when a cast-off pattern is created.

Keywords: forensic science, cast-off stains, bloodstain pattern analysis, FARO Zone 3D, Path Volume Envelope

Supervisor: Eugene Liscio, 3D Forensic Technologist, ai2-3D

BIANCA LEDO

Defining patterns and behaviours of forward spatter gunshot misting

ABSTRACT

Purpose: The purpose of this research is to define patterns and behaviours in forward spatter misting bloodstains by shooting a firearm through ballistic gel to determine if there is a relationship between bloodstain pattern size as a function of distance and orientation. This research is significant as it can aid in crime scene reconstruction by providing new information on forward spatter misting patterns. **Background**: There is a lack of research on forward spatter, blood traveling in the direction of the bullet, as most studies focuses on back spatter. **Methodology**: A firearm was shot through ballistic gel and a blood chamber, depositing the bloodstain onto paper. The distance and angle between the ballistic gel and the paper varied. In total, there were 34 trials, the distances observed were 10cm, 20cm, 40cm and 80cm, the three angles tested were 30o, 60o, and 90o. A criterion was established to determine bloodstain pattern size. A criterion was established to assess bloodstain pattern size. The bloodstain pattern was divided into zones to observe the overall area and horizontal symmetry. **Results**: Graphs and linear regression analyses indicated a significant relationship between the bloodstain pattern size and the paper's angle and distance (R2=0.87); as well as the horizontal symmetry of the bloodstain pattern (R2=0.93). **Conclusion**: The angle and distance between the ballistic gel and paper can impact the bloodstain pattern's symmetry and size. This research provides a criterion and primitive information on forward spatter misting patterns which can be used by blood pattern analysts.

Keywords: forensic science, bloodstain pattern analysis, firearms, ballistic gel, crime scene reconstruction

Supervisor: Eugene Liscio, 3D Forensic Technologist, ai2-3D Forensics

MADISON BIGGIN

Investigating methods of recovering DNA from blood deposited in snow

ABSTRACT

Purpose: The purpose of this experiment was to assess the effectiveness of three collection methods in the recovery of deoxyribonucleic acid (DNA) from blood deposited in snow. Effectiveness was assessed on the basis of the quantity and quality of DNA recovered. **Background**: Typically, 0.5 nanograms (ng) of non-degraded DNA is required to generate a complete DNA profile, which can then be used to link an individual to a crime scene. Blood must be collected in a manner that does not degrade the DNA within; however, no protocol exists to collect blood from snow. In this experiment, non-degraded DNA is represented by a degradation index (DI) of less than 1.5. **Methodology**: Blood was collected from snow onto cotton swabs (n=10), filter paper (n=10), and FTA paper (n=10). Each blood sample consisted of 0.5 milliliters of human blood, dropped at approximately four degrees Celsius from a height of one meter into freshly fallen snow. DNA was extracted from the samples using the QIAamp DNA Investigator Kit, and the quantity and quality assessed using the Quantifiler Trio DNA Quantification Kit. **Results**: The average amount of DNA obtained from the swab, filter paper, and FTA paper samples was 3.57ng/µL +0.805 SD, 28.0ng/µL +6.77 SD, and 5.44ng/µL +1.82 SD, respectively. The average DI reported from the swab, filter paper, and FTA paper samples was 0.733 +0.237 SD, 0.599 +0.153 SD, and 0.683 +0.260 SD, respectively. **Conclusion**: Each method of collection was found to be effective in the recovery of DNA from blood deposited in snow.

Keywords: forensic science, DNA quantification, degradation index, cotton swab, filter paper, FTA card

Mentor: Irv Albrecht, Bloodstain Pattern Analyst, Toronto Police Service

VICTORIA TORRES

Determining the time since deposition of bloodstains using DSLR cameras and Adobe Photoshop

ABSTRACT

Purpose: The purpose of this research is to create a novel technique for determining the time since deposition (TSD) of human bloodstains using DSLR cameras and Adobe Photoshop RGB values. This research is significant as it will increase the cost- and time-efficiency of casework while utilizing equipment already approved by investigative services. **Background**: The majority of TSD research thus far has used expensive, time-consuming laboratory equipment. Two studies have utilized smartphones with digital editing software, but no study has used DSLR cameras and Photoshop together. **Methodology**: Three 50µL human bloodstains were each deposited onto poster, bedsheet, wood flooring, and tile (n=12). Over the course of four weeks, photographs of each bloodstain were taken with a DSLR camera. Using Photoshop's Color Selector Tool, five RGB readings were taken from the perimeter of each bloodstain photograph, and another five from their interior. Average RGB values were plotted against time, and relationships were analyzed using correlation and regression. **Results**: Spearman's Rho correlation tests showed strong negative correlations between bloodstain TSD and perimeter R values on poster, wood, and tile (ρ=-0.936, -0.952, and -0.900, respectively), and interior R values on wood (ρ=-0.949). A statistically significant regression was not obtained ($R^2<0.90$ and $p>0.05$). **Conclusion**: There exists a relationship between bloodstain colour and TSD, which is detectable on some surfaces using DSLR cameras and Photoshop. There is potential for this technique as a bloodstain TSD determination method if the relationship can be quantified for predictive purposes.

Keywords: forensic science, forensic identification, bloodstain pattern analysis, bloodstain aging, digital analysis, crime scene investigation, photography

Supervisors: Clayton Asano, Detective Constable, Peel Regional Police; Robert Hofstetter, Detective, Peel Regional Police

LINDA LAM

Accuracy of Leica RTC360 and Map360, on determining bullet trajectories

ABSTRACT

Purpose: The purpose of the proposed research is to determine the accuracy of bullet trajectories produced by a 3D laser scanner (Leica RTC360) and associated software (Map360), by comparing software produced angles to known bullet angles. Validating the scanner and software will potentially allow for more efficient reconstructions of shooting scenes, and provide investigators scientific backing in practice as well as in court. **Background**: A component of a bullet's trajectory is its impact angle, which can be resolved into a horizontal and vertical component. Traditionally, angles are determined with the ellipse method or manual measurements with trajectory rods. Map360 has tools such as dynamic labelling and bullet path reconstruction to determine angles. **Methodology**: Bullet holes were created using a Glock 22 generation 4 with 0.40 caliber bullets into two surfaces – drywall and car door, secured to a stand 5m away. The surfaces were adjusted to five vertical and horizontal angles, 30°, 45°, 60°, 75° and 90°. Three bullet holes were made for each angle (n=60). Trajectory rods were inserted and two scans were taken using Leica RTC360. The scans were aligned and imported into Map360 to determine the angles. **Results**: The difference between the calculated and known angles was 0-4°, with one outlier of 14°. The maximum mean error for horizontal and vertical angles is 2.33° and 6° including the outlier, respectively. The error excluding the outlier is 2.33°. **Conclusion**: Excluding the outlier, results show that angles produced by Leica RTC360 and Map360 are accurate and within the acceptable range of error (±5°).

Keywords: forensic science, shooting reconstruction, 3D forensics, laser scanner, bullet trajectory

Supervisor: Kelly Canning, Detective Constable, York Regional Police Forensic Identification Unit

ANDREW LO

Determining the accuracy of estimating a shooter's position based on cartridge case ejection patterns

ABSTRACT

Purpose: The purpose of this study is to propose a new method to approximate a shooter's position based on modelling of a weapon's cartridge case ejection pattern. This research is significant as there are no blind studies that determine the accuracy of estimating a shooter's position based on cartridge case ejection patterns. **Background:** Cartridge cases are a form of evidence that is routinely found at shooting incidents. Ejected cartridge cases may be useful in crime scene investigations and shooting reconstructions when the location of a shooter is unknown. There are currently no standards or generally accepted procedures to test and determine the cartridge case ejection pattern or how well a shooter's position may be determined. **Methodology:** This study utilized a Glock 22 Gen. 4 firearm with .40 calibre S&W ammunition to develop a statistical ejection pattern model with 312 ejected cartridge case locations. The positions of the cartridge cases were used to calculate an average X, Y, distance, total distance, and angle which was used as a correction factor. **Results:** The average X(414.44 cm), Y(-129.57 cm), total distance(455.311 cm), and angle(68.98°) were obtained. Blind data sets of ejected cartridge cases with a known direction of fire were obtained and tested with this model to estimate a shooter's position and compared to the true distance. **Conclusion**: It was found that with increasing number of cartridge cases used in a testing set, the error decreased respectively. This study proposes a new method for investigators to use in crime scene reconstruction to aid in estimating a shooter's position.

Keywords: forensic science, firearms examination, cartridge cases, bullets, cartridge case ejection, shooter position, crime scene reconstruction, shooting incident reconstruction

Supervisor: Eugene Liscio, ai2-3D Forensics

LUNCH BREAK

A 25 minute recess, resuming at 1:40pm

MELISSA DUFFY

Fingerprint development on paper: ninhydrin and zinc chloride or 1,2-indanedione and ninhydrin

ABSTRACT

Purpose: This research compared the effectiveness of two sequential latent fingerprint development processes, 1,2-indanedione followed by ninhydrin and ninhydrin followed by zinc chloride, on white paper using split depletion series and Bandey Scale grading. The study compares these methods based on quantified effectiveness on a common substrate, demonstrating the superior method for visualizing identifiable fingerprints, useful for forensic identification. **Background**: 1,2-indanedione followed by ninhydrin is a common effective method for developing latent prints on paper. However, 1,2-indanedione application is time-consuming. Considering police & identification service's high caseloads, an efficient and more effective method is sought-after. An alternative is ninhydrin followed by zinc chloride, which was compared to 1,2-indanedione followed by ninhydrin. **Methodology**: Ten randomly selected donors produced three depletion series of ten impressions that were then split in half, which provided 300 impressions to test each method. After reagent development of both processes, impressions were photographed and graded 0-4 using the Bandey Scale, with scores of 0-2 being unidentifiable and 3-4 being identifiable. **Results**: A chi-square test showed a significant difference between the method's effectiveness ($X2 = 30.17$, d.f.=1, $p<0.05$; $p = 3.96x10\text{-}8$). The odds ratio found the probability of developing an identifiable print using 1,2-indanedione and ninhydrin is increased by 3.83 compared to ninhydrin then zinc chloride. **Conclusion**: This study showed that 1,2-indanedione followed by ninhydrin produced a higher number of identifiable prints than ninhydrin followed by zinc chloride, which supports its use at the Toronto Police Service Forensic Identification Services.

Keywords: forensic science, latent print development, sequential process, porous substrate, zinc salts, indanedione, ninhydrin, Bandey Scale, split depletion series

Supervisors: Jaclyn Slaney, Cameron Power, and Mary Oliveiro, Lab Technicians, Toronto Police Service Forensic Identification Services

JOSHUA WONG

Latent fingerprints in freezing temperature

ABSTRACT

Purpose: The purpose of this research is to determine the effectiveness of using a hairdryer to recover latent fingerprints that have been exposed to freezing temperatures (sub-zero degrees Celsius). This study was conducted by comparing samples with 4 common fingerprint powders that were treated with a hairdryer and samples that were not treated with a hairdryer. This study is significant as there is a lack of literature on this topic, as well as establishing a novel technique for forensic identification officers to recover fingerprints in cold conditions. **Background**: Previous studies have shown that exposure to cold temperatures causes the quality of fingerprints to diminish significantly. **Methodology**: 420 fingerprint samples donated by the author were deposited, collected, and analyzed. Three sample groups existed; a control, fingerprints not treated with a hairdryer, and fingerprints treated with hairdryer. Fingerprints were deposited onto 3 different surfaces: acrylic, metal, and glass. Following a 2-hour exposure to freezing temperatures, fingerprints were processed accordingly depending on the sample group. Fingerprints not treated with a hairdryer were directly processed by each of the 4 fingerprint powders: black, white, analytical gray, and fluorescent orange. Fingerprints that were treated with a hairdryer was subjected to heat application at 37.8 °C for 10 seconds at a distance of 10 cm between the impression and hairdryer. Collected fingerprints were photographed and distributed to 10 fingerprint examiners at Peel Regional Police, where examiners will score quality of fingerprints using the Bandey Scale. **Results**: TBD (fingerprints awaiting to be scored by experts)

Keywords: Forensic science, forensic chemistry, fingerprints, latent fingerprints, cold temperatures, freezing, heat application

Supervisor: Clayton Asano, Detective Constable, Peel Regional Police

ASHLEY MOO-CHOY

Validity of Forensim simulated genotype data for modeling individuals in North American populations

ABSTRACT

Purpose: The purpose of this study is to assess whether Forensim accurately models real-world data via a statistical comparison to heterozygosity from Novroski et al. (2016). With the expanding scope of research in forensic biology and the impracticality of performing benchwork for extensive empirical studies, simulating genotypes using calculation and simulation software is particularly useful. **Background:** The R package *Forensim* is a statistical tool with great potential for use in genotype and mixture simulation. However, *Forensim*'s function as a simulation software lacks proof of scientific validity, as few groups have tested the full capabilities of the software. **Methodology:** Assessment of accuracy was performed via statistical comparison of calculated heterozygosity values from Forensim-generated data to real-world values obtained from Novroski et al. (2016). For each of the 27 autosomal forensically-relevant STR loci, 100 replicate genotypes were generated per population (self-identified as African-American, Caucasian, Asian, and Hispanic), and the mean of the calculated heterozygosity values were used for comparison. **Results:** It was determined via one-sample t-test analyses that 63.89% of total expected heterozygosity (H_e) values across populations exhibited no statistically significant difference between *Forensim* data and control, with 24.07% of total observed heterozygosity (H_o) values, comparatively. **Conclusion:** While these values are not sufficient to prove validity, the results suggest that with corrections to the methodology used, *Forensim* exhibits potential in being able to simulate genotypes representative of real-world populations. Accuracy may be further improved by using additional replicates or testing real-world data that was sourced from a larger number of individuals.

Keywords: forensic biology, population genetics, DNA modeling, genotype simulation, forensim

Supervisor: Nicole Novroski, PhD, Forensic Geneticist, Department of Anthropology, University of Toronto Mississauga

ELIZA BRADLEY

Effects of folate deficiency on transporter pathway expression in glial cells

ABSTRACT

Purpose: This research investigates the folate transporter expression in glial cells, and the effects of pyrroloquinoline quinone (PQQ), an enzymatic cofactor, in upregulating folate transporter expression using primary cultures of mixed glial cells of mice and real-time polymerase chain reaction (qPCR) to quantify changes in gene expression. **Background:** Folates, a family of B9 vitamins, are important in neurodevelopment. Mammals uptake folate through three major transporter pathways: the reduced folate carrier (RFC), proton-coupled folate transporter (PCFT) and the folate receptor alpha (FRa). PQQ can activate a signaling pathway that increases RFC expression at the blood-brain barrier, but its effects on glial cells were not yet characterized. **Methodology:** 4-5 mice ages 1-3 days old underwent whole-brain isolation, and brains were made into primary cultures of mixed glial cells. Primary cultures were exposed to either a folate sufficient or deficient environment. Cells were exposed to a 5 micromolar dose of PQQ or a vehicle-treated control for either 24 or 48 hours. Each trial was repeated 3 times. Cell's gene expression associated with folate transporter receptors was measured using qPCR. The changes in gene expression between groups were quantified using statistical analysis. **Results:** RFC was found to be highly expressed relative to both PCFT and FRa in mixed glia. In RFC expression, a significant increase between cells treated with PQQ and the control was observed, and no significant decrease between folate sufficient and deficient groups. **Conclusion**: These findings demonstrate that PQQ can upregulate RFC expression in conditions of folate deficiency in glial cells.

Keywords: forensic science, forensic pathology, central nervous system, neurodevelopment, pyrroloquinone quinone, reduced folate carrier

Supervisor: Dr. Reina Bendayan, Professor, Leslie Dan Faculty of Pharmacy

MATTHEW PREBEG

Admissibility of forensic psychology expert testimony: a systematic review

ABSTRACT

Purpose: The purpose of this research is to determine what admissibility criteria Ontario appellate judges rely upon in evaluating expert psychological opinion evidence ("psychological evidence"). This research may be significant in supporting or refuting literature critiquing psychological evidence for being overly relied upon despite its admissibility being questionable. **Background**: Psychological evidence is used in criminal trials to assist the trier(s) of fact in drawing conclusions on mental health and psychology as it pertains to the case in question, such as its use in risk assessment and eyewitness memory. Past research has suggested psychological evidence may be unnecessary, prone to bias, and utilizing invalid forensic psychological tools, thus criticizing its admissibility. **Methodology**: A systematic review of 135 Ontario criminal appellate cases since 2011 was conducted. 10 cases were appealed for reasons related to the admissibility of psychological evidence. The discussions of admissibility criteria, expert characteristics and court characteristics of these cases were coded for and analyzed for frequency. **Results**: Necessity was the most discussed admissibility criterion (5 cases), of which the appellate judges ruled none of the psychological evidence in these cases fulfilled. Necessity was also most associated with appeal dismissal (4:1 cases). **Conclusion**: The issue of necessity is most prevalent regarding the admissibility of psychological evidence, potentially supporting the notion that this criterion requires greater discussion in the field of forensic psychology. The small population size, however, may indicate the degree that these issues are discussed on appeal may not be as great frequent as other disciplines.

Keywords: forensic science, forensic psychology, admissibility, Mohan, Ontario, criminal law, appellate law

Supervisor: Claire Horsnell, Assistant Director, Innocence Project, Osgoode Hall Law School

PHOEBE HO

Forensic Science Internship in the age of COVID-19

ABSTRACT

Purpose: The purpose of this research is to investigate the impact of online experiential learning internships in the time of COVID-19 through personal reflection and information gathered from the Experiential Learning (EL) Office at the University of Toronto Mississauga (UTM). This research is significant as it will provide suggestions for future online internships and highlight areas of development. **Background**: Assignment of internship placements in forensic science at the beginning of the COVID-19 pandemic for the 2020-2021 school year. Internships were formalized as either fully online or hybrid models and their methods changed in association with the Ontario regulations as they were released. **Methodology**: Personal reflection and information from the EL office at UTM was used to conduct remote analysis.15 questions were formulated based on personal reflection. Themes were also identified through personal reflection and analyzed for discussion. **Results**: Discussion with the EL officer provided context for EL experiences. It was noted that the number of internships varied greatly according to the nature of placements and host organizations' response to COVID-19. From personal reflection, themes relating to the effects of COVID-19 and the effects of online internships were identified. **Conclusion**: There is a likelihood that online internship placements will continue post-pandemic as organizations have learned to adapt to this method. Recommendations for future online placements encompass maintaining plans, meetings, and scheduling as they would be set for in-person placements.

Keywords: forensic science, COVID-19, internships, online learning, University of Toronto Mississauga, experiential learning

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COLLABORATIVE RESEARCH INTERNSHIP

JESSICA R. BURNS

Psychopathic offenders in forensic practices: sharing experiences, insights, and perceptions

ABSTRACT

Purpose: This study sought to explore forensic practitioners' use of psychopathy assessments by surveying practitioners working in Ontario-based forensic institutions to provide insight into the applications and justifications of psychopathy assessments to answer questions about concerns of misuse, and frequency of use. **Background**: Recently debate has emerged as to whether using psychopathy assessments for the purposes of judicial and correctional decision making is supported by empirical research. Much of this debate is based in anecdotal evidence, as the literature is lacking. **Methods**: The researchers contacted the department heads of the 11 forensic mental health institutions under the Ontario Review Board, and invited them to participate in a 10–15-minute survey. The department heads forwarded the invitation onto the practitioners working in their institutions. The survey received 17 responses. Results: Practitioners reported on which psychopathy assessment tools they have used; PCL-R – 58.80%, PCL-SV – 29.41%, PCL-YV – 0.06%, DSM-5 – 0.06%, LSRP – 0.06%, PPI-R – 0%, CAPP – 0%, TriPM – 0%. Of those who had ever conducted a psychopathy assessment, only one stated that they conducted more that 15 annually. **Discussion**: The finding that only one individual used the DSM-5 may suggest either a movement, of clinicians, away from Antisocial Personality Disorder (ASPD) and towards psychopathy, or, perhaps, that clinicians choose to keep ASPD and psychopathy separate. The number of assessments conducted annually differs from the estimated numbers of psychopaths in prison, suggesting a potential base rate issue. **Conclusion**: The findings of our study confirm previous research on the subject as well as raising novel concerns.

Keywords: psychopathy, forensic science, assessments, PCL-R, utility

Supervisor: Rasmus Rosenberg Larsen, Assistant Professor, University of Toronto Mississauga

DANIELLE SNG

The base rate of psychopathy is significantly lower than shown in literature.

ABSTRACT

Purpose: The purpose of this portion of the study is to explore forensic practitioners' patient demographics by surveying practitioners affiliated with Ontario institutions. This research is significant because it aims to find novel information about the composition of psychopathic individuals in these institutions based upon the applications of psychopathy assessment tools. **Background**: There have been discussions about the substantiated utility of psychopathy assessments in legal and clinical settings. However, there is only anecdotal evidence and no empirical research to support any claims. **Methods**: The survey included questions about demographics, usage and perceived utility of psychopathy assessment tools, and the practitioners' perceptions on psychopathy. Supervisors from institutions operating under the Ontario Review Board were contacted to distribute the survey to its practitioners. A sample of seventeen practitioners from six institutions completed the survey. **Results**: Only one participant reported regularly assessing individuals over the score of thirty for the Psychopathy Checklist-Revised (PCL-R), implying that patients classified as a PCL-R psychopath (scoring 30 and above) are rare in this sample. **Conclusion**: The low proportion of psychopaths in the sample suggests a lower amount of psychopathy assessments, and thus, a lower accuracy of assessments. Future research should investigate the proportion of psychopaths in institutions with a larger sample to map out of the true extent of the psychopathic offenders in forensic psychiatric institutions.

Keywords: forensic science, forensic psychology, assessment, base rate, psychopathy

Supervisor: Rasmus Rosenberg Larsen, Assistant Professor, University of Toronto Mississauga

REBA KHOSHABE

Practitioners' beliefs on the importance of psychopathy assessments contradict empirical research

ABSTRACT

Purpose: The purpose of this portion of the study is to explore forensic practitioners' use and perceived utility of psychopathy assessments by surveying practitioners working in Ontario-based forensic institutions. This research is significant because it will provide insight into the concrete applications of psychopathy assessments and the relation between perceived and empirically substantiated utility. **Background**: Previous studies have claimed that psychopathy measures can predict criminal behaviour, inform treatment decisions, and predict a lack of conscience. Recently, there has been anecdotal evidence used to indicate that certain uses of psychopathy assessments are not validated. **Methodology**: Independent researchers referenced related survey literature to construct a survey on perceptions of psychopathy. A list of Ontario-based forensic institutions operating under the Ontario Review Board (ORB) was created by two other researchers. The supervisors of the 11 ORB institutions were contacted for survey distribution, obtaining a sample of 17 forensic practitioners (i.e., nurses, social workers, psychologists, psychiatrists, and individuals selecting "other") from the participating six institutions. **Results**: A descriptive analysis of the results revealed a discrepancy between practitioners' perceived importance and frequency of use of psychopathy assessments. Practitioners' beliefs seem to contradict the empirical research since importance ratings were significantly higher than frequency ratings for purposes not empirically validated by the literature. **Conclusion**: The observed discrepancies can indicate that psychopathy assessments may be used for purposes they are not empirically justified for. Researchers will use this data for replication to determine if it is truly the case that psychopathy assessments are wrongfully utilized in practice.

Keywords: forensic science, forensic psychology, psychopathy, assessments, utility

Supervisor: Rasmus Rosenberg Larsen, Assistant Professor, University of Toronto Mississauga

NICOLE RAPOSO

Practitioners have mixed perceptions on the rehabilitation potential of psychopaths.

ABSTRACT

Purpose: The purpose of this research is to explore perceptions of psychopathy by surveying practitioners working in Ontario-based forensic institutions. The aim is to gain novel information about practitioners' attitudes and beliefs about psychopathy, which will further our understanding of how perceptions of psychopathy influence the applications of psychopathy assessments. **Background**: There have been debates surrounding the applications of psychopathy assessments, with some researchers raising concerns that certain forensic uses are not empirically justified. However, much of these debates are based primarily on anecdotal evidence, as there is little empirical research examining the concrete uses of psychopathy assessments, or the influence of perceptions in various legal contexts and decisions. **Methodology**: Surveys were distributed to practitioners working at 11 forensic institutions operating under the Ontario Review Board. The survey included questions regarding (1) Demographic Characteristics, (2) Practices, Training, and Communication, (3) Perceived Utility of Psychopathy Assessments, and (4) Perspectives on Psychopathy. **Results**: The majority of practitioners endorsed the position that there is no treatment that can cure a psychopath and were undecided as to whether criminal psychopaths can be rehabilitated. Practitioners were also divided in their responses regarding psychopaths' ability to change over time. **Conclusions**: Practitioners' perceptions on immutability and rehabilitation potential are inconsistent with recent empirical findings. These results provide insight into how practitioners view psychopathy as a construct and give practitioners, researchers, and other professionals working in forensic fields, a greater understanding of how practitioners may apply psychopathy assessment tools.

Keywords: forensic science, forensic psychology, criminal psychopaths, treatment, psychopathy assessments

Supervisor: Dr. Rasmus Rosenberg Larsen, Professor, University of Toronto Mississauga

ADVIKAA DOSAJH

Guidelines with worked example for method optimization: reducing the learning curve

ABSTRACT

Purpose: This research aims to develop a set of optimization guidelines that can be adopted into analytical laboratory protocols to maximize accuracy, precision, reproducibility, and repeatability. There is currently limited literature available on the optimization of forensic techniques, and it is not widely implemented in laboratories. The set of guidelines and worked example will help overcome the learning barrier, leading to wider adoption of this technique. **Background**: Optimization through chemometric means allows for multi-variable analysis. This study employs optimization through analyses: Plackett-Burman and Yates Pattern. The former identifies statistically significant parameters, and latter adjusts those parameters compatibly to reach desired results. **Methodology**: These guidelines are accompanied with a worked example to facilitate understanding. A chemical analysis technique for determining blood alcohol concentration using headspace-gas chromatography was optimized. **Results**: 1: Determine analytical protocol to optimize results; for the worked example, efficiency of the column was analyzed. 2: Select all potentially significant parameters; for the example these were: flow rate, column oven temperature, sample oven temperature, and injection temperature. 3: Perform Plackett Burman analysis on parameters. 4: Determine statistically significant parameters; for the example these were: mobile phase flow rate and sample oven temperature. 5: Perform Yates Pattern analysis on significant parameters. 6: Perform statistical analysis to determine compatible means of adjusting the significant parameters. **Conclusion**: The guidelines can be implemented in any laboratory for optimizing analytical protocols. The learning tool will assist in implementation of this technique by breaking the concepts down into manageable steps and help analysts yield ideal results.

Keywords: forensic science, forensic chemistry, chemometrics, optimization, Plackett-Burman, Yates Pattern, headspace GC-FID, blood alcohol concentration analysis

Supervisor: Vivienne Luk, Ph.D., Assistant Professor, University of Toronto Mississauga

TAJHARAE JARRETT

Assessing the effectiveness of concept maps in a transdisciplinary field

ABSTRACT

Purpose: The purpose of this research is to assess the effectiveness of a concept mapping exercise on student learning and engagement in a transdisciplinary field. This research is significant because it will provide perspective on concept mapping as a potential pedagogical tool for fields that incorporate a diverse set of disciplines. **Background**: Concept maps are node-and-link diagrams that show the relationships between different concepts. Concept mapping has been demonstrated to be an effective pedagogical tool in individual disciplines, but its effectiveness has yet to be assessed in transdisciplinary fields, where multiple disciplines are integrated into one. **Methodology**: After completing a concept mapping assignment, students in a first-year undergraduate forensic science course participated in a voluntary survey assessing their perspectives on concept map usefulness. From the survey, quantitative and qualitative data were coded using emerging themes. **Results**: The survey data (N=235) indicates that students found concept mapping to be effective. Emerging themes identified from the qualitative data were: connections – students were able to identify their own links between disciplines; deep learning – concept mapping improved student understanding of course content; utility – students found the concept maps useful; creativity – students appreciated having creative freedom with the assignment; and engagement – students enjoyed creating the concept map. For the quantitative data, the percentage of students who agreed or strongly agreed to Likert statements under these themes were recorded; connections 85%, deep learning 78%, utility 75%, creativity 68%, engagement 59%. **Conclusion**: The research demonstrates that concept maps can be viable pedagogical tools for teaching and learning within a transdisciplinary field.

Keywords: forensic science, forensic education, pedagogy, interdisciplinary, multidisciplinary

Supervisor: Vivienne Luk, Ph.D., Assistant Professor, University of Toronto Mississauga

YIYAN WU

The application of cross-course collaboration between Forensic Identification and Forensic Chemistry

ABSTRACT

Purpose: The purpose of this study is to examine students' subjective perception on the effectiveness of cross-course collaboration between Forensic Identification and Forensic Chemistry from three perspectives, connectedness between courses, relevancy of training, and learning experience, through surveys and critical reflective assignments. The significance of this research is to increase the options for effective learning in forensic science. **Background**: Students from different courses work together to solve a problem in a cross-course collaboration. This pedagogical approach has been demonstrated to be effective in individual disciplines, but not in fields requiring collaboration of distinct disciplines. **Methodology**: This cross-course collaboration module between Forensic Identification and Forensic Chemistry is a mock case investigation, which mirrors the real-world investigation procedure. This research evaluated the survey responses and critical reflective assignments from sixty students enrolled in Forensic Chemistry in Fall 2018, 2019 and 2020, in order to gauge their perception of the modules. **Results**: For connectedness, there was a 32% increase in students who clearly recognized the connectedness between Forensic Identification and Forensic Chemistry, whereas a 26% increase for connectedness among all Forensic disciplines. For relevancy of training, 98% and 87% students agreed or strongly agreed that the collaborative modules helped them better understand their roles in an investigation and understand the course material and its application better than that of a non-collaborative. For learning experience, over 85% students would like more collaborative modules. **Conclusion**: Cross-course collaboration improved students' perception of connectedness between courses, relevancy of training, and their learning experience. Therefore, it is an effective pedagogical method.

Keywords: forensic science education, collaborative learning, interdisciplinary collaboration, interprofessional education, pedagogy

Supervisor: Vivienne Luk, Assistant Professor, University of Toronto Mississauga

SAMANTHA CHUI

COVID-19 and the courtroom: The effect of camera angle on juror perception of expert witnesses in virtual testimonies

ABSTRACT

Purpose: The purpose of this research is to examine whether camera angle influences juror perception of the credibility of an expert witness in a virtual trial. The findings of this study will be beneficial for informing expert witnesses of best practices for presenting evidence in a virtual setting, which has become a common occurrence due to COVID-19. **Background:** Research has shown that factors beyond the evidence being presented play a role in influencing jury decision making, such as physical appearance, body language, or facial expressions. **Methodology:** Seventy-two jury-eligible members of the public participated in one of four mock trials as jurors. Mock trials were held on Zoom, in which an expert witness was cross-examined by the Crown regarding a fentanyl trafficking case. In two of the mock trials, the expert witness positioned the camera at eye level such that they could be visible from the chest up (n=38). In the remaining two mock trials, the expert witness positioned the camera at a low angle such that they could be visible from the head up (n=34). Participants completed the Witness Credibility Scale (WCS) which assesses credibility according to four factors: knowledge, confidence, trustworthiness, and likeability. **Results:** A Mann-Whitney U test compared ratings of the expert witness across the two camera angle conditions. No significant difference was found for the overall score (p=0.65567), as well as each of the four factors of credibility. **Conclusion:** Camera angle is not a salient factor, and thus does not have a statistically significant effect on jury perception of an expert witness.

Keywords: forensic science, expert witness credibility, camera angles, COVID-19, juror perception, remote testimony, trial preparation, videoconferencing

Supervisor: Caitlin Pakosh, LD, Forensic Science Program, University of Toronto Mississauga

JESSICA FREED

Jury Perception: the effect of camera angle during virtual delivery of expert testimony through the videoconferencing application Zoom

ABSTRACT

Purpose: This study explores the feasibility of virtual jury trials through examining the consequences camera angle when an expert witness delivers virtual testimony to a jury. **Background:** Videoconferencing for the delivery of expert witness testimony has increased in Ontario since the onset of the COVID-19 pandemic. The application "Zoom" has become an essential tool in the continuation of operations for courts in the province. At this time, virtual jury trials have not yet occurred in Ontario. **Methodology:** This research explored the possible effect on juror perception of an experimental camera angle where the camera was tilted away from the presenter resulting in only the face of the expert witness being visible on screen. In comparison, the control camera angle allowed the expert to be visible from the shoulders to the top of the head. Four mock jury trials, consisting of approximately 20 participants for each trial, were conducted virtually through Zoom. Participants viewed expert testimony from a forensic toxicologist, then completed an anonymous survey based on the Witness Credibility Scale (WCS). The WCS uses Likert scales to rank the witness' credibility through likeability, trustworthiness, confidence, and knowledge. **Results:** Wilcoxon rank sum test was used to compare the medians of the survey data. Across all four categories, as well as an overall credibility analysis, the Wilcoxon Rank Sum test yielded no statistically significant results. **Conclusion:** This study found that camera angle did not have a statistically significant impact on juror perception of the credibility of the virtual expert witness.

Keywords: Forensic science, expert witness testimony, virtual testimony, expert witness, Zoom, videoconferencing, juror perception, Witness Credibility Scale, WCS, Wilcoxon rank sum, COVID-19

Supervisor: Caitlin Pakosh, LD, Forensic Science Program, University of Toronto Mississauga

BRIANNA LEGERE

COVID-19 and the courtroom: Exploring the effect of camera angle on juror perception of expert witnesses in virtual testimonies

ABSTRACT

Purpose: This article aims to evaluate if low camera angle has an impact on a juror's perception of an expert witness' credibility in a simulated trial setting. **Background**: The impacts of the COVID-19 pandemic may necessitate the increased use of videoconferencing in the courtroom in order to facilitate testimonies by expert witnesses. The credibility of an expert it important to both the admissibility and weighing of their evidence by the court. It is possible that controllable technological factors, like camera angle, could impact the way a juror perceives an expert and their testimony. **Methodology**: Jury-eligible participants from Ontario, Canada (n=72) acted as jurors in a mock drug trafficking trial and viewed remote testimony by a certified forensic toxicologist. Control group participants (n=34) saw the expert at a camera angle that visualized them from the chest up, while experimental group participants (n=38) saw experts from a low angle such that only their head was visible. Participants then evaluated the expert's credibility using the Witness Credibility Scale (WCS)—20 Likert-scale questions assessing traits related to confidence, trustworthiness, likeability, and knowledge. **Results**: A Wilcoxon rank sum test compared the distribution of scores on the WCS between the control and test groups. At a 95% confidence interval the p-value was 0.3300, showing that the difference in distributions was not statistically significant and the null hypothesis cannot be rejected. **Conclusion**: The use of a low camera angle in video testimony did not appear to have an impact on jurors' perception of expert witness credibility.

Keywords: Remote testimony, expert witness credibility, Witness Credibility Scale, juror perception, camera angle, videoconferencing

Supervisor: Caitlin Pakosh, LD, Forensic Science Program, University of Toronto Mississauga

MEGAN RODRIGUES

COVID-19 and the courtroom: Exploring the effects of camera angle on jury perception of expert witnesses in virtual testimony

ABSTRACT

Purpose: This study is conducted to assess whether camera angle affects jury perception of expert witnesses during virtual testimony. This study is significant in helping expert witnesses prepare for online testimony and in developing best practices for virtual trials. **Background**: The COVID-19 pandemic has made Ontario courts more inclined to allow expert witnesses to testify remotely to ensure public safety. Current literature states that non-evidence related factors (i.e. appearance) affect jury perception of expert witness credibility; however, there is little information on the influence of technical factors associated with videoconferencing (i.e. camera angle) on jury perception during virtual testimony. **Methodology**: Jury-eligible participants (n=72) viewed a live mock trial in which an expert witness testified on a drug trafficking case. The camera angle of the expert witness varied between the control and experimental groups, such that in the control group (n=34) the witness could be seen from the chest up and in the test group (n=38) only the witness' head could be seen. Using the Witness Credibility Scale, participants assessed the witness' overall credibility by evaluating four factors: knowledge, likeability, trustworthiness, and confidence. The median scores for each category and overall credibility were used for comparison between the two groups. **Results**: A Mann-Whitney U test showed that between the two groups, there was no statistically significant difference in the median scores for expert witness' overall credibility (p=0.66), likeability (p=0.59), trustworthiness (p=0.38), confidence (p=0.34), or knowledge (p=0.87). **Conclusion**: Camera angle has no statistically significant impact on jury perception of expert witness credibility.

Keywords: Forensic science, forensic psychology, courtroom, expert witness credibility, jury perception, videoconferencing, virtual testimony, Witness Credibility Scale.

Supervisor: Caitlin Pakosh, University of Toronto Mississauga

ELENA TEMELKOVA

The Courtroom and COVID-19: Can an expert witness's camera angle affect jury perception during virtual testimony?

ABSTRACT

Purpose: The purpose of this study is to examine the importance of a controllable technological factor—computer camera angle—during an expert witness's virtual testimony by running a virtual mock-trial, and how this factor may influence the jury's perception of that witness. This research is significant because it will aid in establishing best practices for the courts when structuring virtual testimonies. **Background**: The COVID-19 pandemic has forced Ontario courts to use technology and hold many trials virtually via video conferencing applications. Before the pandemic, virtual expert testimony was granted in special circumstances whereas now, expert witnesses can testify virtually in judge-alone trials to mitigate the spread of COVID-19. **Methodology**: Jury-eligible participants (n=72) watched a single mock-trial via Zoom of an expert witness providing testimony for a drug-trafficking case. The control group (n=34) watched an expert who had their camera angle set to show their mid-chest to the top of their head, whereas the experimental group (n=38) watched an expert who had their camera angle set to show only their head. Using the Witness Credibility Scale (WCS), participants rated the expert's likeability, confidence, trustworthiness, and knowledge to assess credibility on a 10-point Likert-Scale. **Results**: A Mann-Whitney U test indicated that there was no statistically significant difference between the distributions of the two groups in regard to overall perception of expert credibility ($p=0.66$, $p> .05$). **Conclusion**: Camera angle did not significantly affect jury perception. These results suggest that best practices for virtual testimony do not need to place high emphasis on camera angle.

Keywords: forensic science, forensic psychology, COVID-19, expert witness credibility, jury perception, virtual expert testimony, virtual trial, Witness Credibility Scale

Supervisor: Caitlin Pakosh, University of Toronto Mississauga

FSC489H5

ADVANCED INDEPENDENT PROJECT

LOURDES BUTTON

Opioid-related deaths in Ontario correctional facilities and penitentiaries (2009-2019)

ABSTRACT

The opioid crisis is a significant public health care issue in Canada with opioid-related deaths increasing each year. Although studies have been published regarding the incidence of opioid-related deaths in the general population there is limited information regarding deaths in the Ontario prison population related to opioids. To investigate the impact of the opioid epidemic in this vulnerable population, a retrospective study of all drug related deaths that occurred in Ontario correctional facilities and penitentiaries between 2009 and 2019 was conducted. A total of 91 deaths were attributed to acute drug toxicity and the decedents ranged in age from 18 to 63 years and comprised 82 men and 9 women. The results of this study indicate the number of drug related fatalities have increased by 375% (from 4 to 19) over the last 10 years. The detection of opioids in drug-related deaths have increased with fentanyl being the most frequently detected drug. Data also indicates the recent emergence of fentanyl related analogues in this population. The results from this study provide useful information about drug-related deaths in the Ontario prison system, and provide insight into how the opioid crisis and the increased use of fentanyl and its analogues have affected this vulnerable population.

Keywords: opioids, overdose, incarceration, pathology

Supervised by: Dr. Karen Woodall, Professor of Forensic Toxicology, University of Toronto

ROBIN YI SHENG LOW

Investigating the underlying genetic differences of Canada's cannabis strains

ABSTRACT

Purpose: This study aims to explore the gaps in knowledge regarding genetic sequence analysis of cannabis strains and deepen our understanding of the relationship between cannabis molecular biology and its pharmacology. Currently, there remains an uncharacterized amount of variability within strains of cannabis when sequenced via microsatellite analysis and compared using the common sativa/indica classifications. Genetic engineering of a strain for a particular medicinal or recreational use requires understanding of these underlying mechanisms. **Background**: The recent legalization of cannabis in Canada has led to a proliferation of different strains of cannabis designed for individual preferences, such as high THC with low CBD for recreational use. With over 2000 strains of cannabis, developing an accurate classification system based on genetic composition has proven to be difficult, and the underlying cannabinoid biosynthesis is largely unexplored. **Methodology**: Scientific articles in the field of cannabis genetics and pharmacology, along with enthusiast websites were reviewed to assess genetic and toxicological difference qualitatively and quantitatively in five identified strains: Blue Dream, Gorilla Glue #4, Cannatonic, Wedding Cake, and OG Kush. **Results**: Although differences in toxicological information surrounding these strains were readily available, the genetic differences proved difficult to find. Misclassification of indica/sativa breeds as well as genetic variations within cannabis sold under the same name has further obscured accurate analysis. **Conclusion**: To fully appreciate the diversity of available strains, further genotyping to understand them at a genomic level is required as to allow for correlations to be developed between the toxicological phenotypes expressed.

Keywords: forensic science, forensic biology, forensic toxicology, cannabis genetics, genotyping

Supervisors: Dr. Nicole Novroski, Assistant Professor, Research Stream, University of Toronto Mississauga; Dr. Karen Woodall, Assistant Professor, Teaching Stream, University of Toronto Mississauga

BETHANY KREBS

Processing fingerprints at large scenes: the viability of a fluorescent starch powder medium and dispersal through a sandblaster

ABSTRACT

Purpose: The purpose of this research is to assess the viability of dispersing novel fluorescent starch powder through a sandblaster to develop latent fingerprints. This method may be more efficient, economical and less invasive than brush application and may be a particular asset in developing latent prints in large crime scenes. **Background**: Past research has examined the viability of aerosolized powder application to reduce the risk of damaging the print and streamline latent print development of large areas. **Methodology**: Two donors deposited a total of 144 sebaceous fingerprints on 6 substrates – painted drywall, galvanized steel, treated hardwood, ceramic tile, laminate countertop and glass – in depletion series. After aging in a non-laboratory environment for 0,1,4, and 11 days, the samples were sprayed with Chameleon Colors® fluorescent cornstarch powder by a gravity-feed sandblasting gun powered by an air compressor. **Results**: No evidence of contact was seen in 8 prints; 12 prints showed evidence of contact; 14 showed limited development; 10 indicated strong development; and 100 prints exhibited full development. Seventy-six percent of fingerprints (n=110) exhibited sufficient quality and detail for identification. Tile, glass, metal, wood and countertop substrates yielded excellent development on days 0,1 and 4, with variable results on day 11. Tile produced excellent results (100% identifiable) across all fingerprint ages. The powder fluoresced under UV and 450 nm light (with KV550 orange filter), further enhancing detail and contrast. **Conclusion**: Application of a novel fluorescent starch powder with a sandblaster is a simple, effective, non-toxic, economical and resource-efficient technique.

Keywords: forensic science, forensic identification, fingerprints, powder application, starch powder, sandblaster, large scene

Supervisor: Wade Knaap, Assistant Professor – Teaching Stream, Forensic Science Program, University of Toronto Mississauga

NATASHA MAHADEO

Using the fluorescent chemistry of highlighters to modify the enhancement capabilities of Luminol in detecting bloody footwear impressions.

ABSTRACT

Purpose: The purpose of this research study is to explore if the fluorescent chemistry of highlighters and different dyes can improve upon the limitations that Luminol possesses and enhance its ability to specifically detect bloody footwear impressions. This would allow for Luminol to again be a useful option and could provide for many helpful applications in the field. **Background**: The literature highlights that there has been a move towards the use of BlueStar instead of Luminol due to its limitations such as requiring complete darkness to view the reaction and the intensity and longevity of the luminescence. **Methodology**: Different highlighters and dyes were tested in comparison to the original Luminol. To the Luminol formulation, Fluorescein, Rose Bengal, Rhodamine B, two types of yellow highlighter ink and a green highlighter ink were added separately. These formulations were then tested on bloody footwear impressions in a depletion series of three. Each formulation, and the original Luminol comparison, was tested on the three depletions in both complete darkness and in dim light. Each sample was photographed. The top four successful methods were then timed to analyze the longevity of the reaction. **Results**: Five out of the six methods tested showed positive results in improving upon the limitations, Fluorescein being the one to show positive results in all four categories tested. **Conclusion**: The fluorescence of highlighters and other dyes proved to be a way in which the limitations of Luminol could be improved in order to again make it a viable contender for crime scene use.

Keywords: forensic identification, forensic science, Luminol, fluorescence, footwear impressions, blood, Fluorescein, Rose Bengal, Rhodamine B, highlighters

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